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FOREST PEST MANAGEMENT

3430 BIOLOGICAL EVALUATION
R2-82-8

WESTERN SPRUCE BUDWORM
IN THE ROCKY MOUNTAIN REGION
1982

United States
Department of

Forest Service

Forest Pest Management
Denver, Colorado

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WESTERN SPRUCE BUDWORM IN THE ROCKY MOUNTAIN REGION 1982

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ABSTRACT

In 1982, the western spruce budworm defoliated approximately 1.8 millon acres of forest in Colorado and .2 million acres in Wyoming. Defoliation severity in most of Colorado was light and in Wyoming defoliation was moderate to heavy.

Budworm egg mass surveys were expanded this year to include infested areas in Wyoming and areas west of the Continental Divide in Colorado. In Colorado, survey results indicate that egg mass densities have declined significantly from 1981 levels and only light or moderate defoliation is predicted for 1983. In Wyoming, egg mass densities are very high and heavy defoliation is expected next summer.

INTRODUCTION

The western spruce budworm, *Choristoneura occidentalis* Freeman, is the most serious defoliator in the Rocky Mountain Region. In this region, the insect feeds primarily on Douglas-fir and true fir and occasionally on Engelmann spruce and other tree species. The budworm larvae feed primarily in buds and on foliage of the current year.

Defoliation becomes most noticeable early in summer when the remains of recently chewed needles cause the trees to appear reddish-brown. Significant tree damage occurs after several consecutive years of defoliation. Stands infested for several years assume a gray appearance as a result of tree top-kill and mortality.

Budworm outbreaks occur periodically and may last from five to fifteen years. Intervals between outbreaks vary from a few years to several decades. The population dynamics of the budworm are not fully understood. However, climate and host physiological condition are believed to be important factors in budworm outbreaks and subsequent population collapses. Rapid outbreak collapses have resulted from unusual weather occurrences, principally late spring frosts (Klein 1967, Fellin et al. 1972, McKnight 1971).

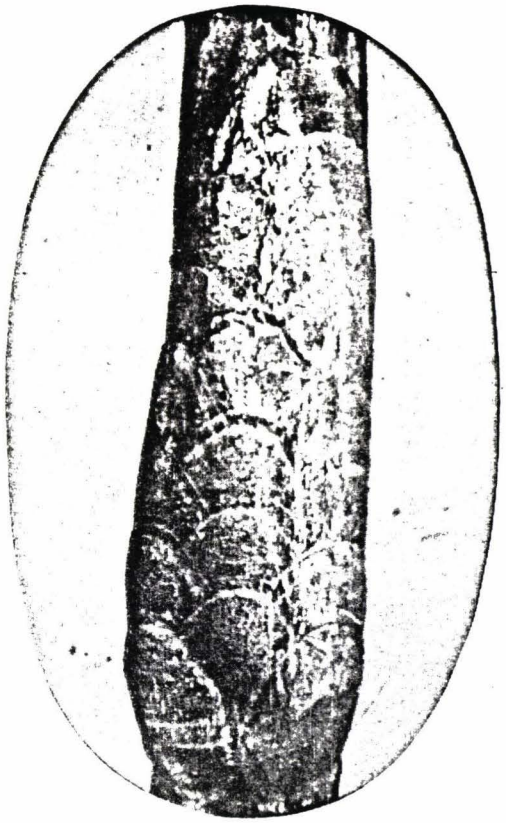
Forest Pest Management monitors the western spruce budworm through annual aerial detection and egg mass surveys. Annual surveys are conducted to provide concerned land managers with information about extent, intensity and predictions of budworm population activities within the Region.

Permanent plots for gathering egg mass and defoliation data were first established throughout the Region in the early 1960's. From 1978-1981, however, data was only gathered from permanent plots on the Colorado Front Range. In 1982, sampling was expanded to again include areas west of the Continental Divide in Colorado and on the Shoshone National Forest in Wyoming. The aerial survey was completed in July. The egg mass survey was conducted during August and September.

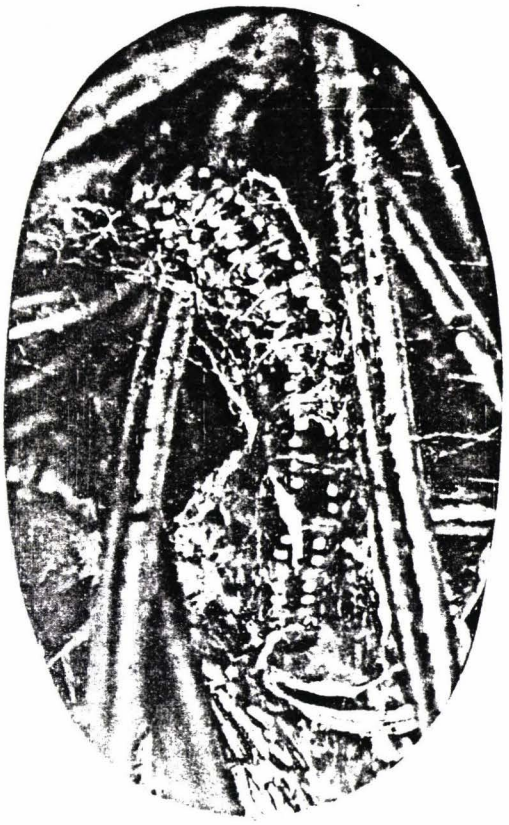
BIOLOGY OF THE WESTERN SPRUCE BUDWORM

The western spruce budworm has one generation per year in Colorado. The adult budworm is a small, mottled, gray to reddish-brown moth which appears bell-shaped when motionless (Figure 1D). During July and early August, moths may be found flying about the crowns of host trees.

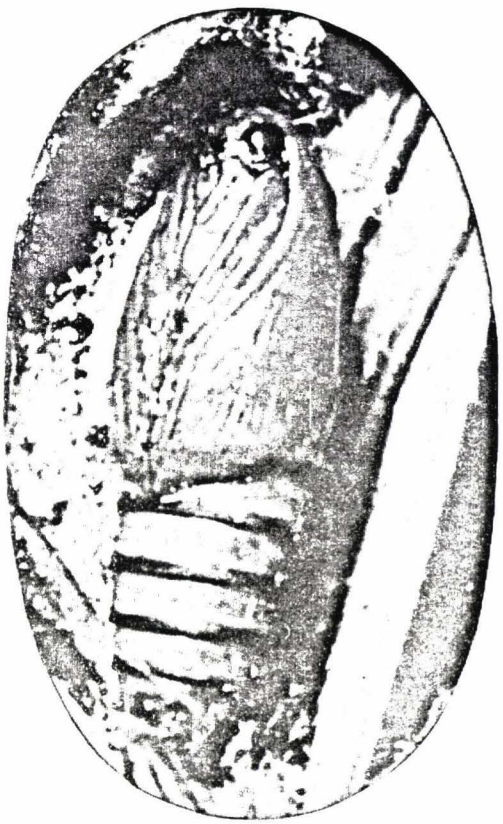
Shortly after mating, females deposit eggs in masses attached to the undersides of needles of host trees (Figure 1A). Within days, the eggs hatch. The newly hatched larvae do not feed. Instead, they disperse to seek protective over-wintering sites such as under bark scales, in twig crotches or among lichens. Once in these sites, the larvae spin silken shelters and hibernate.



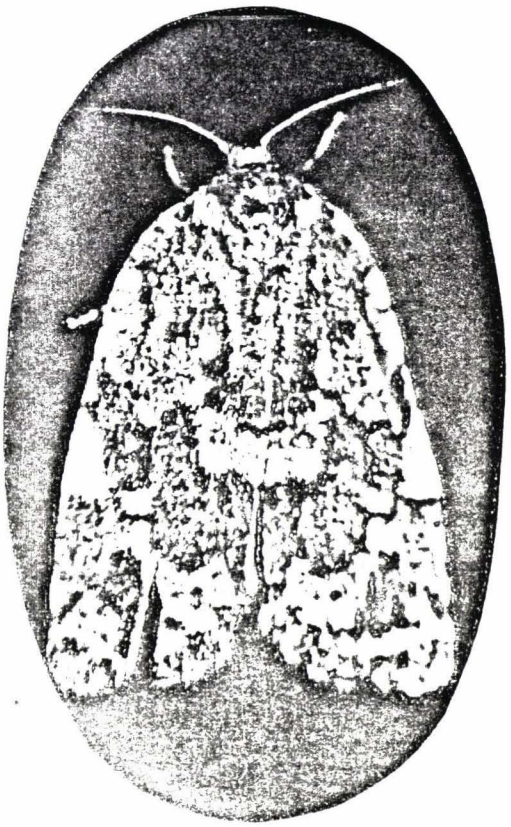
A. Eggs on underside of needle



B. Larva on branch tip



C. Pupa on branch tip



D. Adult

Figure 1. Life stages of the western spruce budworm, *Choristoneura occidentalis* Freeman.

In the spring, larvae disperse from their shelters to the foliage where they mine old needles for one to two weeks. As the buds begin to expand, larvae move onto and consume the new foliage. Mature larvae are a little over an inch long, brown to olive in color, with whitish dots on the top side of each segment (Figure 1B). Older larvae construct a feeding niche by spinning webs between shoots. By early July, larvae transform to an inactive pupal stage within the feeding webs (Figure 1C) and adults emerge from the pupae within several days.

EXTENT OF THE OUTBREAK

In 1982, aerial surveys indicated approximately two million acres were infested in the Rocky Mountain Region (Figure 2). Budworm infested acreage in the area is displayed in Table 1.

Table 1. 1982 Western Spruce Budworm Defoliation Acreage by Land Ownership Class 1/

	National Forest	Other Federal	State	Private	Total
Arapaho	13,379	3,521	8,042	10,549	35,491
Gunnison	47,813	53,780	680	10,734	113,007
Pike	559,822	320	640	108,916	669,698
Roosevelt	259,059	38,356	1,700	120,444	419,559
San Isabel	34,615	11,013	-	36,910	82,538
San Juan	466,130	18,574	1,130	15,000	500,834
Shoshone	172,643	7,760	-	1,651	182,054
TOTAL	1,553,461	125,564	12,192	311,964	2,003,181

1/ Acreage defoliated by budworm was determined from aerial sketch maps made at the time of peak defoliation.

The current outbreak of western spruce budworm began in the mid 1970's. In Colorado, forest lands affected by the insect include portions of the Front Range, Wet Mountain, Sangre de Cristo Range, San Juan Mountains, West Elk Mountains, and the Powderhorn Mountains. In Wyoming, areas affected include portions of the Absaroka Range and Wind River Range.

Figure 2. 1982 western spruce budworm defoliation in the Rocky Mountain Region

The western spruce budworm occurs in all Douglas-fir and true fir forest types within the Region. Budworm damage is most noticeable and severe in pure stands of Douglas-fir and in mixed conifer stands where the Ponderosa pine component is small. In stands where Douglas-fir is a minor component, damage is less severe.

EVALUATION METHODS

Egg mass density is used to monitor spruce budworm trends, evaluate long term effects of control projects and to forecast defoliation. Defoliation predictions are based on year-to-year changes in the density of new egg masses on branch samples collected from the midcrown of the host trees (Carolin and Coutler, 1959, 1972).

Since 1978, sampling was restricted to permanent, fixed radius plots established within infested areas of National Forests on the Colorado Front Range. This year sampling was expanded to include plots west of the Continental Divide in Colorado and in infested areas of the Shoshone National Forest in Wyoming. Table 2 shows the names and locations of the areas sampled in 1982.

Plots consisted of three dominant or codominant host trees within close proximity. From each tree, two 24 inch branches were pruned from the midcrown for a total of six branches per plot. These foliage samples were bagged, labeled, and transported to the laboratory where new egg mass densities were determined. A stereoscope was used to separate new from old egg masses and to measure the length of each egg mass.

Egg mass density classes and associated defoliation are displayed in Table 3. These classes are adapted from McKnight (1970) and were refined by Linnane (1979) based on four years of data from the fixed plot, cluster tree, sampling scheme.

Current year's defoliation estimates were based on the percent of missing needles of new growth determined by an ocular examination. The two branches from each tree were given a combined defoliation rating based on the classes defined in Table 3. Egg mass and defoliation data were compiled and analyzed using a computer program developed by the USDA Forest Service, Methods Application Group, Fort Collins, Colorado.

Table 2. Locations of 1982 Egg Mass Sampling Plots

Forest	Plot Name	Location
Shoshone	Hunter Peak C.G.	T.57N. R.106W. Section 21
	Rocky Ford	T.56N. R.106W. Sections 1, 11, 14
	Camp Creek	T.56N. R.105W. Sections 10 & 14
	Badger Springs	T.56N. R.105W. Section 24
	Sinks Canyon	T.32N. R.101W. Sections 24 & 28
Roosevelt	Devils Gulch	T.5N. R.72W. Section 4
	Big Elk Meadows	T.3N. R.72W. Sections 1 & 11
		T.4N. R.72W. Section 36
	Magnolia Road	T.1S. R.71W. Sections 5 & 8
Pike	Ormes Peak	T.13S. R.68W. Sections 1 & 2
	Indian Creek	T.8S. R.69W. Sections 10 & 14
		T.8S. R.70W. Section 19
San Isabel	Oak Creek P.G.	T.20S. R.70W. Section 19
	Balman Reservoir	T.46N. R.12E. Section 6
	Alvarado C.G.	T.23S. R.73W. Section 5
	Beulah	T.23S. R.68W. Sections 28 & 29
	Spring Creek	T.31S. R.69W. Section 4
San Juan	Blanco Basin	T.35N. R.2E. Section 30
	Wolf Creek C.G.	T.37N. R.1E. Section 16
	East Fork	T.36N. R.1E. Section 7
	Cimarrona C.G.	T.38N. R.3W. Section 8
	Pine River C.G.	T.37N. R.6W. Section 26
	Vallacito Reservoir	T.37N. R.6W. Section 16
		T.36N. R.6W. Section 8
	Old Timers C.G.	T.36N. R.6W. Section 20
	Transfer Park C.G.	T.37N. R.7W. Section 19
	Coon Creek	T.37N. R.8W. Section 33
	Haviland Lake C.G.	T.38N. R.9W. Section 25
Gunnison	Soap Creek C.G.	T.50N. R.4W. Section 32
	Powderhorn	T.46N. R.3W. Section 1

Table 3. Defoliation prediction classes for western spruce budworm egg mass sampling in Region 2.

Class	Mean Number of New Egg Masses Per Square Meter Foliage	Defoliation Prediction 1/
1	1.6 or less	Undetectable
2	1.7 to 10.0	Light
3	10.1 or more	Moderate to Heavy

1/ Defoliation expected on new growth only

Undetectable	0-10%
Light	10-35%
Moderate	35-65%
Heavy	65-100%

RESULTS

Arapaho National Forest: Aerial surveys indicated that approximately 35,491 acres were defoliated on National Forest and adjacent lands in 1982. Detectable defoliation decreased significantly from the 1981 estimate of 192,000 acres. No egg mass density data was gathered from the Arapaho National Forest.

Gunnison National Forest: About 113,007 acres were defoliated on National Forest and adjacent lands in 1982. This is approximately the same area defoliated in 1981.

Egg mass and defoliation surveys were conducted in two areas, Soap Creek and Powderhorn. In 1982, defoliation was moderate at Soap Creek and at Powderhorn. Egg mass densities indicate that light defoliation is expected for the Soap Creek area and light to moderate defoliation is expected for the Powderhorn area for 1983 (Table 4). Egg mass density and defoliation data was not gathered from the Gunnison National Forest in recent years. Therefore, no comparison of data was possible.

Table 4. Results of Egg Mass and Defoliation Survey on the Gunnison National Forest in 1982.

Area	Number of Branch Samples	1982 Defoliation Estimate	Mean Number of New Egg Masses per Square Meter Foliage	1983 Defoliation Prediction
Soap Creek	30	Moderate	5.9	Light
Powderhorn	36	Moderate	26.8	Moderate to Heavy
Summary	66	Moderate	16.4	Moderate to Heavy

Pike National Forest: Aerial surveys indicate that approximately 669,698 acres were defoliated in 1982 on the Pike National Forest and adjacent lands. In 1981, about 663,000 acres were defoliated.

Two areas were sampled for egg mass density and defoliation severity data. (Table 5). In the Indian Creek area, defoliation was light and the egg mass density was equal to that found in 1981. In the second area, Ormes Peak, defoliation was moderate. No new egg masses were found on the branches collected from the Ormes Peak area. This is a significant decrease from the 29.5 egg masses per square meter of foliage found in this area in 1981. Defoliation at Ormes Peak, therefore, is expected to be undetectable in 1983.

Table 5. Results of Egg Mass and Defoliation Survey on the Pike National Forest in 1982

Area	Number of Branch Samples	1982 Defoliation Estimate	Mean Number of New Egg Masses per Square Meter Foliage	1983 Defoliation Prediction
Indian Creek	120	Light	21.9	Moderate to Heavy
Ormes Peak	6	Moderate	0	Undetectable
Summary	126	Moderate	11.0	Moderate to Heavy

Roosevelt National Forest: Three areas were sampled. Survey results are presented in Table 6. Approximately 419,559 acres were defoliated on National Forest and adjacent lands. This is a significant increase over the 366,000 acres of defoliation reported in 1981.

Egg mass densities at the three permanent sample locations (Big Elk Meadows, Magnolia Road, and Devil's Gulch) declined sharply from 1981 levels. Defoliation in 1982 was light in all the areas sampled. In 1983, moderate to heavy defoliation is predicted at Big Elk Meadows and Magnolia Road while light defoliation is expected at Devil's Gulch.

Table 6. Results of Egg Mass and Defoliation Survey on the Roosevelt National Forest in 1982

Area	Number of Branch Samples	1982 Defoliation Estimate	Mean Number of New Egg Masses per Square Meter Foliage	1983 Defoliation Prediction
Big Elk Meadows	104	Light	10.7	Moderate to Heavy
Magnolia Rd.	54	Light	10.6	Moderate to Heavy
Devil's Gulch	30	Light	9.2	Light
Summary	188	Light	10.2	Moderate to Heavy

San Isabel National Forest: An aerial survey indicated approximately 82,538 acres of defoliation on both National Forest and adjacent lands in 1982. Detectable defoliation decreased significantly from the 122,000 acres reported in 1981 (Linnane 1981).

In the past, sampling was limited to the Wet Mountains. This year, egg mass sampling was expanded to include areas on the Sangre de Cristo Mountains and the Spanish Peaks.

Results of the survey on the San Isabel National Forest are displayed in Table 7. Defoliation in each of the five areas was light. Egg mass densities in the Beulah and Balman Reservoir areas indicate that moderate to heavy defoliation is expected in 1983. At the Spring Creek and Oak Creek areas light defoliation is expected and in the Alvarado Campground area, defoliation is expected to be undetectable in 1983.

Among the areas sampled this year, only the Oak Creek area was sampled in 1981. Egg mass density in this area was 5.3 egg mass per square meter this year and 13.5 egg masses per square meter in 1981.

Table 7. Results of Egg Mass and Defoliation Survey on the San Isabel National Forest in 1982

Area	Number of Branch Samples	1982 Defoliation Estimate	Mean Number of New Egg Masses per Square Meter Foliage	1983 Defoliation Prediction
Beulah	54	Light	12.6	Moderate to Heavy
Oak Creek C.G.	30	Light	5.3	Light
Alvarado C.G.	6	Light	1.3	Undetectable
Balman Reservoir	18	Light	15.4	Moderate to Heavy
Spring Creek P.G.	12	Light	5.1	Light
Summary	120	Light	7.9	Light

San Juan National Forest: Approximately 500,834 acres of defoliation were detected this year. This is an insignificant increase over the acreage reported in 1981. Egg mass density and defoliation data were collected from ten areas (Table 8). Egg mass density and defoliation data had not been collected on this Forest since 1978.

Defoliation was generally moderate in all the areas except at the Transfer Park Campground where defoliation was heavy. Egg mass densities at Coon Creek, Pine River, and Vallecito Reservoir indicate the potential for moderate to heavy defoliation in 1983. In all other areas undetectable to light defoliation is expected next year.

Table 8. Results of Egg Mass and Defoliation Survey on the San Juan National Forest in 1982

Area	Number of Branch Samples	1982 Defoliation Estimate	Mean Number of New Egg Masses per Square Meter Foliage	1983 Defoliation Prediction
Blanco Basin	18	Light	1.5	Undetectable
Cimarrona C.G.	18	Moderate	3.3	Light
Coon Creek	6	Moderate	20.8	Moderate to Heavy
East Fork	18	Moderate	5.5	Light
Haviland Lake C.G.	6	Moderate	2.2	Light
Pine River C.G.	12	Moderate	18.6	Moderate to Heavy
Transfer Park C.G.	18	Heavy	6.9	Light
Vallecito Reservoir	24	Moderate	18.5	Moderate to Heavy
Wolf Creek C.G.	18	Light	1.1	Undetectable
Old Timers C.G.	12	Light	9.7	Light
Summary	15	Moderate	8.8	Light

Shoshone National Forest: The greatest increase in spruce budworm activity in the Region occurred on the Shoshone National Forest and adjacent lands. Egg mass densities were higher than in any area of the Region. Between 1981 and 1982 the area of visible defoliation increased 40 percent. In 1982, approximately 182,054 acres of defoliation were detected.

Egg mass density and defoliation data had not been previously collected on the Shoshone National Forest. In 1982, five areas were sampled (Table 9). Defoliation throughout the areas sampled was generally moderate except in the Camp Creek area where defoliation was classified as heavy. Egg mass densities in each of the areas is very high indicating that moderate to heavy defoliation will occur in 1983.

Table 9. Results of Egg Mass and Defoliation Survey on the Shoshone National Forest in 1982

Area	Number of Branch Samples	1982 Defoliation Estimate	Mean Number of New Egg Masses per Square Meter Foliage	1983 Defoliation Prediction
Badger Spring	6	Heavy	61.0	Moderate to Heavy
Camp Creek	12	Heavy	25.5	Moderate to Heavy
Hunter Peak C.G.	12	Moderate	109.9	Moderate to Heavy
Rocky Ford	30	Moderate	73.7	Moderate to Heavy
Sinks Canyon	60	Moderate	30.6	Moderate to Heavy
Summary	120	Moderate	60.1	Moderate to Heavy

SUMMARY

Figure 3 illustrates increases and declines in detectable defoliation from 1978 to 1982 in the Rocky Mountain Region.

Between 1981 and 1982, detectable defoliation in the Region declined about seven percent (Table 10). The most significant decrease occurred along the Colorado Front Range. Detectable defoliation on the Arapaho and San Isabel National Forests declined 82 percent and 32 percent, respectively. Defoliation severity also decreased along the Colorado Front Range, where defoliation was light in 1982 (Table 11).

The greatest increase in budworm activity occurred on the Shoshone National Forest and adjacent lands. The area of detectable defoliation increased from 130,000 acres in 1981 to 182,054 acres in 1982. Heavy defoliation occurred over most of this area.

FIGURE 3 --- WESTERN SPRUCE BUDWORM DEFOLIATION IN REGION 2, 1978-1982.

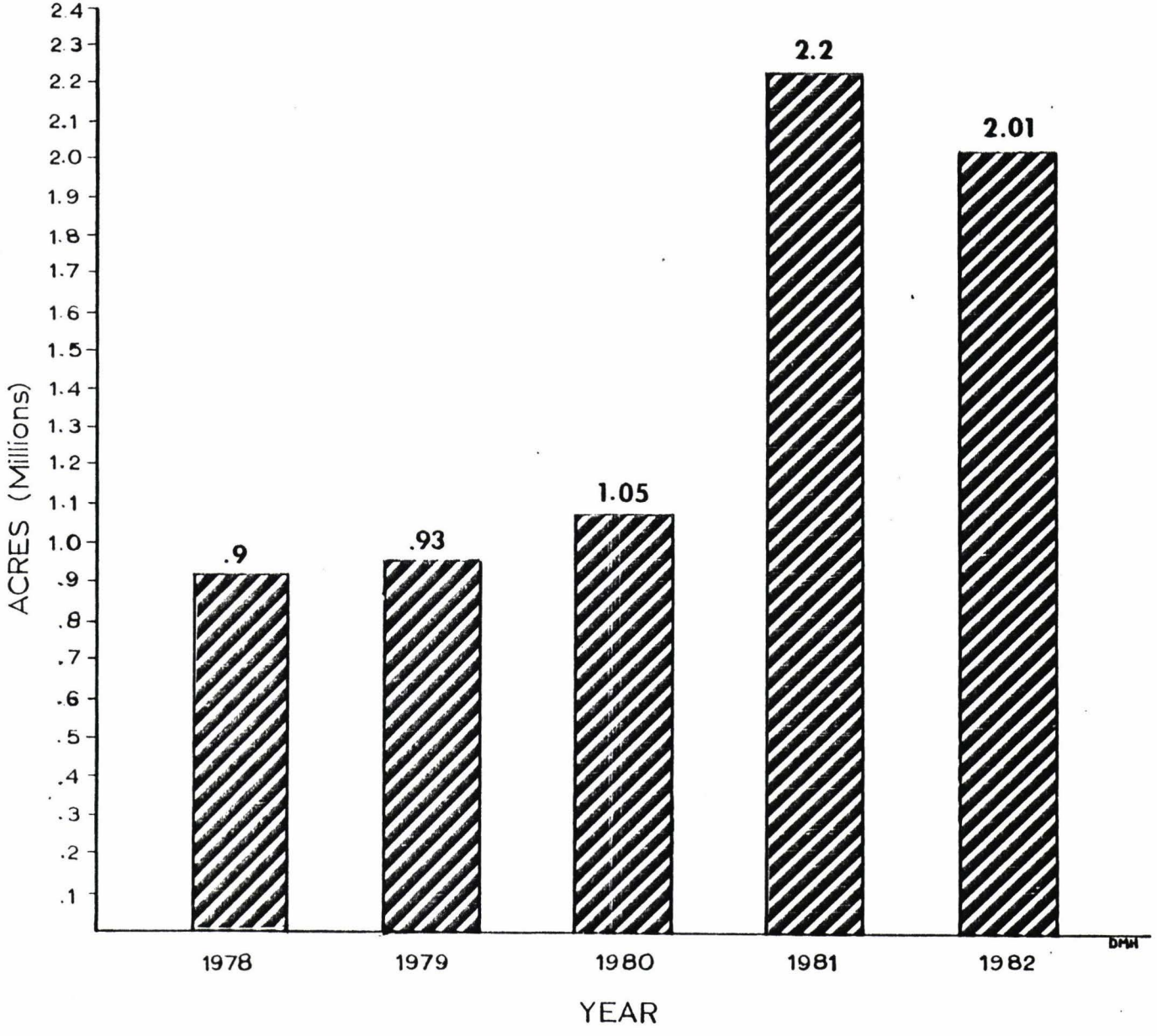
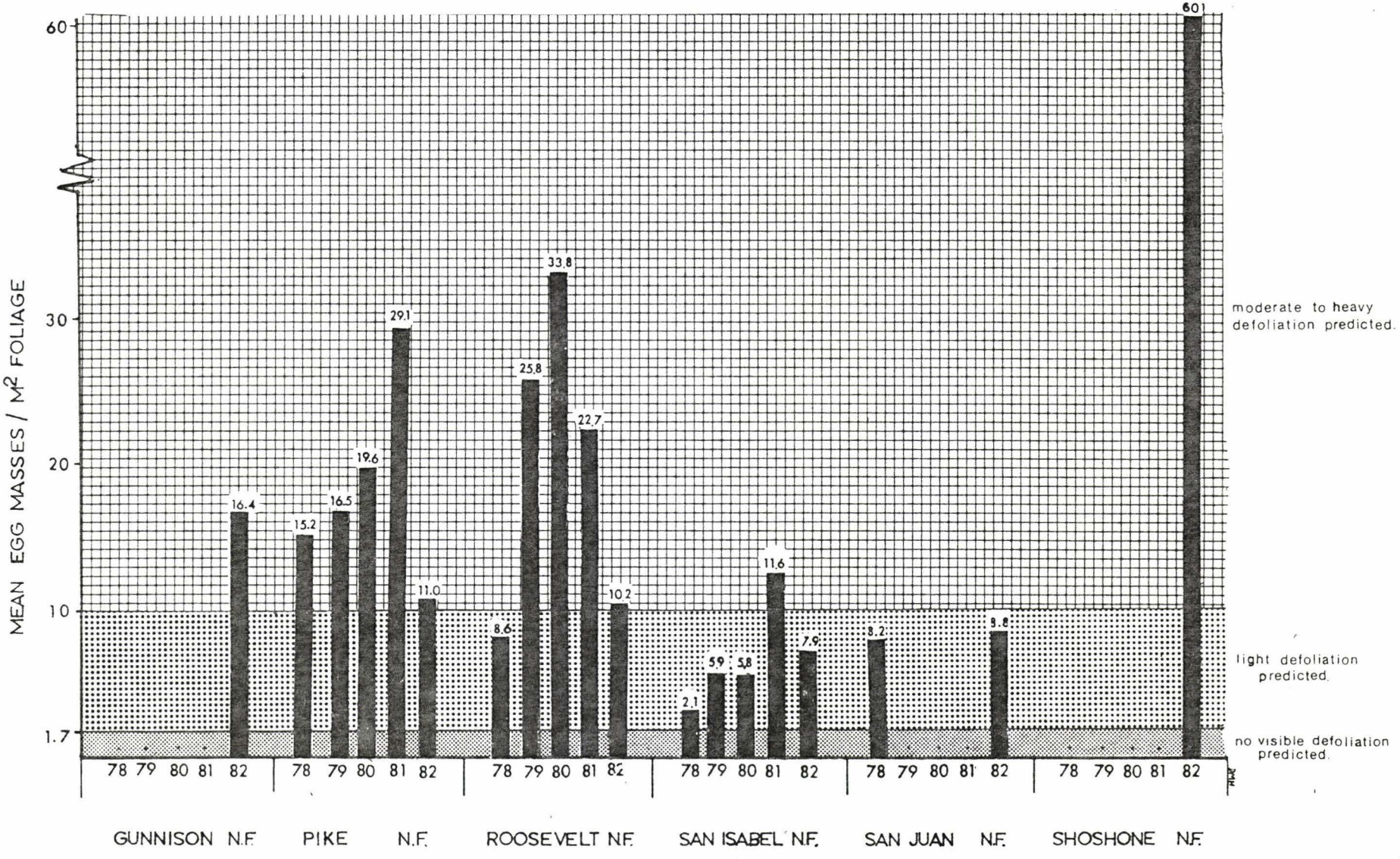


FIGURE 4 --- RESULTS OF THE ANNUAL SPRUCE BUDWORM POPULATION SURVEY IN REGION 2, 1978-1982.



* DATA NOT AVAILABLE.

Table 10. Acres of Western Spruce Budworm Defoliation in Region 2, by Forest, 1981-1982

Forest 1/	Acreage	
	1981	1982
Arapaho	192,000	35,491
Gunnison	120,455	113,007
Pike	663,000	669,698
Roosevelt	366,000	419,559
San Isabel	122,000	82,538
San Juan	570,000	500,834
Shoshone	130,000	182,054
Total	2,163,455	2,003,181

1/ "Forest" in this table refers to not only National Forest land but also land of other ownerships within and adjacent to the National Forest.

Except for the Shoshone National Forest and adjacent lands, egg mass densities have declined significantly throughout the Region. Figure 4 illustrates, particularly, the decrease in egg mass densities on the Forests of the Colorado Front Range. Egg mass densities were much higher in the Shoshone National Forest area than in any other area in the Region.

Table 11. Defoliation Severity in Region 2, 1978-1982.

	1978		1979		1980		1981		1982	
	Predicted	Actual[1/]	Predicted[1/]	Actual[2/]	Predicted[2/]	Actual[3/]	Predicted[3/]	Actual[4/]	Predicted[4/]	Actual
Gunnison NF	*	*	*	*	*	*	*	*	*	Mod
Pike NF		Mod	Mod	Mod	Mod	Light to Mod	Mod to Heavy	Mod	Mod to Heavy	Light
Roosevelt NF		Mod	Light	Mod	Mod	Mod	Mod to Heavy	Mod to Heavy	Mod to Heavy	Light
San Isabel NF		Light	Undetect	Light	Light	Light	Light	Light	Mod to Heavy	Light
San Juan NF		Light	Light	*	*	*	*	*	*	Mod
Shoshone NF	*	*	*	*	*	*	*	*	*	Heavy

* Data not available

1/ Linnane (1978)

2/ Linnane (1979)

3/ Linnane (1980)

4/ Linnane (1981)

ALTERNATIVE ACTIONS

An environmental assessment (EA), prepared in 1982, presented alternative strategies for dealing with the current western spruce budworm outbreak in the Rocky Mountain Region and the environmental consequences of those strategies (USDA Forest Service, 1982). Separate sets of alternatives were identified for undeveloped forest lands and developed forest lands. Following are the alternatives identified in the EA.

A. Alternatives for Undeveloped Forest Lands

Undeveloped forest lands are general forest zones not meeting the developed forest criteria.

1. Maintain Current Management.

2. Silvicultural Management.

3. Direct Suppression with Aerial Applications of Chemical Insecticides.

   Insecticides registered for use against the WSB follow:

   a. Carbaryl (carbamate insecticide).
   b. Acephate (organophosphate insecticide).
   c. Malathion (organophosphate insecticide).

4. Direct Suppression with Aerial Applications of Microbial insecticides.

B. Alternatives for Developed Forest Lands

Developed forest lands include improved campsites and recreation facilities, administrative sites, and critical near and middleground view zones.

1. Maintain Current Management. This is the no action alternative.

2. Silvicultural Management.

3. Protection of Individual High Value Trees with Insecticides.

4. Direct Suppression with Aerial Applications of Chemical Insecticides.

5. Direct Suppression with Aerial Applications of Microbial Insecticides.

In addition, a biological control alternative using parasites and predators was considered, but dismissed because of insufficient information on efficacy and implementation.

RECOMMENDATIONS

The following actions were recommended in the EA for undeveloped and developed forest lands.

A. Undeveloped Forest Lands

For undeveloped forest lands, the alternative, Maintain Current Management is recommended. Although this alternative will result in losses of esthetic and timber values, these losses are judged acceptable based on public opinion, economic evaluation, and current USDA Forest Service policies and objectives.

B. Developed Forest Lands

For developed forest lands, the alternative, Protection of Individual High Value Trees with Insecticides, is recommended because it has little environmental risk, is technically effective, and the least costly suppression strategy.

Forest Supervisors should pay particular attention to developed recreation areas where treatment may be warranted. Rationale for these recommendations are found in the 1982 EA.

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